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that portion of the rope which is suspended between the supports. Also find the amount of work which must be performed in raising the lowest point to make it coincide with the top of the lower support by exerting a pull on the free end of the rope.

[No solution of this problem has been received.]

240. Proposed by G. B. M. ZERR, A. M., Ph. D., Philadelphia, Pa.

A simple beam length $2a$, supported at both ends, is loaded in the form of a parabola, height of vertex b. Find deflection at center due to this load.

Solution by the PROPOSER.

Let AB be the beam, ACD the parabola, $CD=b$, $AD=DB=a$. Take E any point on AB, draw EF perpendicular to AB. Let $AE=x$, and also z be the distance of the center of gravity of the area AEF from EF. Then $\frac{4}{3}ab$=total load. $(x-a)^2+(a^2/b)(y-b)=0$ is the equation to the parabola, with A as origin.

$$\text{Then } (x-z)=\frac{\int\int xdxdy}{\int\int dxdy}=\frac{\int\int xdxdy}{A}.$$

$$\therefore A(x-z)=\int_0^x xydx=\frac{b}{a^2}\int_0^x (2ax^2-x^3)dx=\frac{bx^3}{12a^2}(8a-3x).$$

$$A=\int_0^x ydx=\frac{bx^2}{3a^2}(3a-x).$$

$$\therefore x-z=\frac{8ax-3x^2}{4(3a-x)} \text{ and } z=\frac{4ax-x^2}{4(3a-x)}.$$

Taking moments about A we get,

$$EI\frac{d^2y}{dx^2}=\tfrac{2}{3}abx-Az=\tfrac{2}{3}abx-\frac{bx^3}{3a}+\frac{bx^4}{12a^2}=M.$$

$$EI\frac{dy}{dx}=\tfrac{1}{3}abx^2-\frac{bx^4}{12a}+\frac{bx^5}{60a^2}+C.$$

When $x=a$, $dy/dx=0$, $C=-\frac{4}{15}a^3b$.

$$\therefore EI\frac{dy}{dx}=\tfrac{1}{3}abx^2-\frac{bx^4}{12a}+\frac{bx^5}{60a^2}-\tfrac{4}{15}a^3b,$$

$$Ely=\tfrac{1}{9}abx^3-\frac{bx^5}{60a}+\frac{bx^6}{360a^2}-\tfrac{4}{15}a^3bx=-\frac{61a^4b}{360} \text{ when } x=a.$$

$$\therefore y = -\frac{61a^4b}{360EI} = \text{deflection required.}$$

For cantilever beam, length $2a$, with the same load,

$$EI\frac{d^2y}{dx^2} = -A(x-z) = -\frac{2bx^3}{3a} + \frac{bx^4}{4a^2},$$

$$EI\frac{dy}{dx} = -\frac{bx^4}{6a} + \frac{bx^5}{20a^2} + C; \text{ when } x=2a,\ dy/dx=0,\ C=\tfrac{16}{15}a^3b.$$

$$\therefore EI\frac{dy}{dx} = -\frac{bx^4}{6a} + \frac{bx^5}{20a^2} + \tfrac{16}{15}a^3b.$$

$$EIy = -\frac{bx^5}{30a} + \frac{bx^6}{120a^2} + \tfrac{16}{15}a^3bx = \tfrac{24}{15}a^4b, \text{ when } x=2a.$$

$$\therefore y = \frac{24a^4b}{15\,EI} = \text{deflection at end of beam.}$$

Also solved by Harold Rowe.

242. Proposed by C. N. SCHMALL, 604 East 5th Street, New York City.

In a certain New York theatre there is an asbestos curtain supported by thin circular rings, radius r, which move on a cylindrical rod of radius a. The curtain is intended to be drawn by a *steady pull.* Taking μ as the coefficient of friction, show that this will not be possible if r be less than $a\sqrt{(1+\mu^2)}$.

Solution by G. B. M. ZERR, A. M., Ph. D., Philadelphia, Pa.

Let P be the resultant pull on a ring, θ the angle between the direction of P and the normal to the surface of contact of ring and rod.

Then $P\cos\theta$=resolved part of P along the normal, and $P\sin\theta$=resolved part at right angles to the normal. For equilibrium, $P\sin\theta < \mu P\cos\theta$.

$$\therefore \sin^2\theta < \mu^2\cos^2\theta, \text{ or } \cos^2\theta > \frac{1}{1+\mu^2}.$$

The diameter of the ring is in the direction of P; diameter of rod is the normal.

$$\therefore \cos\theta = \frac{a}{r}. \quad \therefore \frac{a^2}{r^2} > \frac{1}{1+\mu^2} \text{ or } r < a\sqrt{(1+\mu^2)}.$$

243. Proposed by G. B. M. ZERR, A. M., Ph. D., Philadelphia, Pa.

A weight W is supported by three strings of the same size and quality lying in the same plane. The middle string is vertical, one string makes with it an angle θ on one side, and the other string makes with it an angle ϕ on the other side. Find the stresses T_1, T_2, T_3 in the strings.